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### STUDIES IN THE BORAGINACEAE, XXIV

#### A. THREE GENERA SEGREGATED FROM LITHOSPERMUM

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CONCERNED HERE are three species of the Mediterranean and adjacent areas which have been accepted as members of the genus *Lithospermum*, viz., *L. apulum* (L.) Vahl, *L. microspermum* Boiss., and *L. callosum* Vahl. These three plants share a distinctive type of nutlet, and despite their many differences appear to be more closely related to one another than to any of the other species referred to *Lithospermum*. A consideration of their characters gives reasons for treating them as three monotypic genera.

The nutlets in our three species, as compared with those of true *Lithospermum*, are rather small and have a thin pericarp. Above the small, obliquely basal attachment they have a ventral keel formed by the overlapped margins of a closed ventral suture. In contrast the thick-walled, usually much larger and more broadly attached nutlets of *Lithospermum* have the ventral suture more or less obliterated. Its margins are tightly joined, commonly more or less confluent, and not well defined nor merely overlapping. Although our plants are not closely related to *Megastoma*, *Sericostoma*, and *Echiochilon*, the behavior of the ventral nutlet-suture in that group of interrelated genera is suggestive in interpreting that in our three species. In the genera mentioned the suture may be open nearly to the nutlet apex or be closed in varying degree by the overlapping of its margins. This variation is associated with the observable changes from a narrow elongate to a broad low gynobase and the accompanying shift from a distinctly lateral to a more and more basal nutlet-attachment. The suture in our three species, closed simply by the overlapping well-defined margins, gives every evidence of being the end product of a comparable series of changes in nutlet-attachment. In other words our three species probably had immediate ancestry with distinctly lateral rather than basal nutlet-attachment. In contrast, bony basifixed nutlets having the ventral suture obscured or obliterated by fusing and confluence of the seam-margins are present not only in true *Lithospermum* but also in a wide circle of obviously related genera, including such diverse plants as *Onosma*, *Cerithe*, *Echium*, *Alkanna*, etc. This type of nutlet is a stabilized one and

characteristic of a large and obviously old group of genera. It is not one from which the nutlets of our three species could have been derived. The indications are, therefore, that our plants are not directly related to *Lithospermum* or its immediate relatives.

Although having nutlets of a similar basic type, the three species differ from one another in many significant details, and each of them has one or more unusual developments that separate it from all species of *Lithospermum* as well. There seem the best of reasons, hence, for giving each of them generic recognition. Their salient characters are revealed in the following synopsis.

**Moltkiopsis.** Calyx circumscissile at the base. Corolla blue, evidently longer than the calyx, hairy outside, glabrous inside except for hairs on the swollen annular nectary low in the tube. Stamens affixed high in the corolla, two of them having shorter filaments and a slightly lower attachment than the other three, filaments much longer than the anthers. Pollen ellipsoid,  $25-30 \times 20-25 \mu$ , in lateral profile with sides convex or nearly straight or with one of the sides obscurely angled, broadest at the middle; pores three, about the equator. Style elongate, more or less exserted; stigma obscurely bilobed. Nutlets smooth and shiny, somewhat asymmetric, straight. Plant a suffruticose perennial with pallid, pungently bristly foliage and white exfoliating bark on the older stems; cymes small.

**Mairetis.** Calyx tubular, elongate. Corolla blue, very small, scarcely longer than the calyx, with a villulose band inside at the base of the tube but otherwise completely glabrous; nectary not developed. Stamens affixed at equal heights high in the corolla, filaments twice as long as the anthers. Pollen spherical,  $30-33 \mu$  in diameter, with usually eight equatorial pores. Style reaching up to the corolla-throat; stigma simple. Nutlets sparsely warted, nearly straight. Plant an annual herb with inconspicuously bracted cymes.

**Neatostema.** Calyx divided. Corolla yellow, very small, the lobes minutely puberulent, throat with a continuous or broken band of hairs, inside of the tube villulose and bearing a ten-lobed, more or less hairy basal nectary. Stamens borne just above the nectary very low in the corolla; filaments much shorter than the anthers. Pollen ellipsoidal,  $25-30 \times 23-26 \mu$ , in lateral profile with sides slightly angled, broadest at the middle; pores eight, equatorial. Style very short, less than half the length of the corolla; stigma bilobed. Nutlets very coarsely warted, angulate, bent. Plant an annual herb with conspicuously bracted cymes.

**Moltkiopsis, gen. nov.** BORAGINACEAE — LITHOSPERMEAE.

Calyx 5-partitus subsessilis maturitate sub basim loborum circumscissus, lobis lanceolatis conniventibus. Corolla caerulea elongata anguste tubuloso-infundibularis extus villulosa intus (nectario excepto) glaberrima, lobis aequalibus adscendentibus oblongis vel ovatis apice rotundatis, fauce ampliata nuda nullo modo appendiculata vel glandulifera, tubo elongato basim versus nectario annulato tumido non rariter sparse villuloso praedito. Stamina e fauce corollae breviter exserta fere ad apicem tubi corollae inaequaliter inserta, filamentis inaequalibus, duobus antheris aequilongis altitudine sinus corollae attingentibus, tribus antheris sesquilongioribus alti-

tudine supra medium lobis corollae attingentibus, antheris oblongis medio-affixis aequalibus apice rotunda. Pollinia ellipsoidea medio poris 3 donata. Stylus filiformis tarde exsertus stamina evidenter vel vix superans. Stigma depresso-capitatum simplex vel obscure bilobatum. Nuculae saepe 2 vel 3 laeves nitidae lanceo-ovoideae subasymmetricae apice acutae basi angustatae truncatae cicatrice plana parva transverse elliptica donatae dorso et latere rotundatae ventre angulatae. Carina ventralis nuculae margines sulci longitudinali clausi imbricata sed haud confluentes composita. Gynobasis depressa subplana. — Planta humilis perennis suffruticosa ramosa hirsuta. Caules plures erecti cortice albo vetustiore exfoliato obtecti. Folia pallida alterna. Cymae terminales abbreviatae bracteatae. Flores caerulei. — Nomen derivatur a *Moltkia* et ὄψις, habitus, propter similitudinem cum genere *Moltkia*.

**Moltkiopsis ciliata** (Forsk.) comb. nov.

*Lithospermum ciliatum* Forsk. Fl. Aegypt.-Arab. 39 (1775); C. Christensen, Dansk Bot. Ark. 4<sup>3</sup>: 14 (1922).

*Moltkia ciliata* (Forsk.) Maire, Cat. Pl. Moroc. 4: 1102 (1941).

*Lithospermum angustifolium* Forsk. Fl. Aegypt.-Arab. 39 (1775).

*Lithospermum callosum* Vahl, Symb. Bot. 1: 14 (1790). — A renaming of *L. angustifolium* Forsk.

*Moltkia callosa* (Vahl) Wettst. Oesterr. Bot. Zeit. 67: 368 (1918).

*Lithospermum callosum* var. *asperrimum* Bornm. Mitt. Thüringisch. Bot. Verein 6: 58 (1894).

This desert plant, which ranges across northern Africa and east to Iran, has by some been treated as a member of *Moltkia* but by most botanists accepted as a species of *Lithospermum*. Its nutlets, as well as its triporate pollen and circumscissile calyx, distinguish it quickly from all members of both genera. Because of its fruticulose habit and elongate blue corollas its gross habit is most suggestive of *Moltkia*. Its corollas, however, differ from those of *Moltkia* in a number of important details. They are hairy rather than glabrous outside. They have a well-developed nectary in the tube. They bear stamens of two sizes, not at a single but at two levels in the throat. The stamen-attachment is of special interest. As in *Alkanna*, two of the five stamens have filaments shorter and attached slightly lower in the corolla-throat than the other three. Unlike *Alkanna*, however, the two shorter and lower stamens are not juxtaposed nor are they abaxial. They are separated by a long stamen and appear to represent the two adaxial lateral members of the androecium. They are not abaxial laterals as in *Alkanna*. The behavior of the calyx in *Moltkiopsis* is also unusual. As the fruit approaches complete maturity the calyx becomes circumscissile just above the base, its connivent lobes drop away, and the ripe nutlets are completely exposed. After the nutlets are shed all that remains of the flower on the old inflorescence is the knob-like base of the subsessile calyx and the flattened gynobasic surfaces on its truncate summit. This condition is unique among the herbaceous Boraginaceae.

Over most of its wide range the plant has blue subtubular corollas

10–15 mm. long. No evidence of cleistogamy has been detected. The only striking variation noted in the flower is that present among some, not all, plants collected in the region about the Persian Gulf. In these the corollas are very small (3–7 mm. long), the anthers are imperfectly developed, and the style is very short (2.5–6 mm.). The cymes on such plants tend to be very slender, the flowers very crowded, and the bracts unusually small. Although they appear to have functional stigmas, no fruit has been found on plants producing the small crowded flowers described. The condition described may be the result of virus infection. Possibly also it might be an expression of gynodimorphism comparable to that known in *Echium vulgare* and *Anchusa officinalis*. In those species occasional individuals produce not the normal hermaphrodite flowers, but only small functional female ones. Representatives of the small-flowered form of *Moltkiopsis* have been seen from Bushir, southern Persia, 1868, *Haussknecht* (Brit. Mus.), Bahrain Island, *Fernandez* 489 (Kew), and Kuwait, *Dickson* 224 (Kew).

**Mairetis**, gen. nov. BORAGINACEAE — LITHOSPERMEAE.

Calyx elongatus secus costas sparse hirsutus alibi sparse strigosus fere ad medium lobatus, sub anthesin subsessilis corolla paululo brevior tertiam partem inferioribus tubulosus, lobis erectis gracilibus donatus, in statu fructifero 4–5-plo accrescens breviter pedicellatus tubo quam lobis erectis cuneatis 1–2-plo longiore donatus. Corolla minuta symmetrica extus glaberrima, lobis caeruleis erectis vel adscendentibus longitudine corollae 6–7-plo brevioribus, fauce brevi glabra subcampanulata nullo modo appendiculata vel glandulifera, tubo elongato flavo intus basim versus villuloso alibi glabro nectarium haud gerenti. Stamina in fauce corollae aequaliter affixa apice altitudine basim sinus corollae attingentibus; filamentis aequalibus lineari-bus antheris duplo longioribus; antheris ellipticis vel oblongis apice mucronulatis infra medium affixis, thecis infra medium liberis et laeviter divergentibus. Pollinia globosa secus aequatorem poris saepe 8 donata. Stylus filiformis altitudinem staminum attingentibus in statu fructifero nuculis longioribus, stigmatibus capitato haud lobato abundanter papillato. Nuculae saepe 4 cinereae rosaceaeve sparse sed distincte verrucosae ovato-lanceolatae dorse latereque rotundae ventre obtusae carinatae (carinae margines sulci longitudinali clausi imbricatas sed haud confluentes compositae) basi angustatae cicatrice obliqua parva transverse elongata donatae. Gynobasis plana vel laeviter concava. — Planta annua herbacea erecta strigosa. Folia parva alterna. Cymae multibracteatae terminalis scorpoideae, maturitate elongatae secundae inconspicue bracteatae. Corolla minuta fauce et limbo caerulea, tubo flavo. — Nomen, derivatum a Maire et  $\tau\iota\varsigma$ , datum est in honorem cl. René Maire (1878–1939), optime de flora Africae septentrionalis praesertim Moroccae merita.

**Mairetis microsperma** (Boiss.), comb. nov.

*Lithospermum microspermum* Boiss. Diag. ser. 2, 3: 135 (1856) and Fl. Orient. 4: 218 (1875).

*Lithospermum Webbii* Coss. & Dur. Bull. Soc. Bot. France 22: 64 (1875).  
nomen; Ball, Jour. Linn. Soc. Bot. 16: 574 (1878), nomen in syn.

A monotypic genus known only from Morocco and the Canary Islands. The plant is especially notable for its elongate tubular fruiting calyces. At anthesis the calyx is tubular for about a third of its length. At maturity it is greatly accrescent, several times longer than broad and tubular for a half to two-thirds its length. The nutlets, hence, are matured at the bottom of a deep investing calyx-tube. Among some anchusoid borages calyx-tubes are well developed. It is, however, a condition rare among other herbaceous borages and is entirely unknown in *Lithospermum* or any of the closely related genera. The stigma is also unusual. It is capitate and terminal and unlike the stigmas usually developed in the *Lithospermeae* is not only simple but shows no suggestion of lobing.

Although very distinct, *Mairetis* seems to have its closest relationship with *Neatostema* and *Moltkiopsis*. As to annual habit and roughened nutlets it is most like *Neatostema*. Its corolla, because of its color, elongate form, long filaments, and elevated stamen-attachment, is suggestive of that of *Moltkiopsis*, although very different in size. The tiny corolla, scarcely longer than the calyx, is completely glabrous except for hairs low inside the tube on the site of the undeveloped nectary. The stamens are affixed at equal height low in the small corolla-throat and have filaments of equal length. The position of the stamen-attachments is usually marked by small depressions on the outer surface of the corolla.

**Neatostema**, gen. nov. BORAGINACEAE — LITHOSPERMEAE.

*Lithospermum* § *Oxyspermum* Visiani, Fl. Dalmatica 2: 246 (1847).

Calyx 5-fidus, maturitate accrescens, lobis calycis fructiferi conniventibus conspicue costatis. Corolla anguste infundibuliformis symmetrica extus villulosa, lobis adscendentibus vel patentibus ovato-oblongis apice rotundis utrinque minutissime abundanterque glanduloso-puberulentis, fauce nullo modo appendiculato vel glandulifero pilis in annulo circumferentialiter angustaque dispositis vel in locis 5 congestis praedito, tubo intus villuloso supra basim nectarium 10-lobatum villulosum gerenti. Stamina 5 basim versus tubi corollae paulo supra nectarium aequaliter affixa; filamentis perbrevis antheris 4-plo brevioribus, antheris parvis oblongis utroque obtusis rotundisve vel rare basi retusis infra medium affixis. Pollinia ellipsoidea medio poris 8 donata. Stylus brevissimus antheras haud superans maturitate nuculis duplo brevior, stigmate terminali bilobato lobis subglobosis. Nuculae saepe 4 brunneae angulatae evidenter verrucosae paulum curvatae utroque angustatae basi cicatrice parva obliqua donatae dorse convexae saepe verruculis longitudinaliter 4-serratis ornatae ventre obtusae. Carina ventralis nuculae margines sulci longitudinali clausi imbricatas sed haud confluentes composita. Gynobasis fere plana perdepresse pyramidali. — Herba annua hispida erecta humilis. Folia parva alterna. Flores parvi flavi in cymas terminales densas foliaceo-bracteatas mox

elongatas scorpioideas dispositi. — Nomen derivatur a νέατος, infimus, et στήμα, stamen, quod stamina basim versus corollae affixa sunt.

**Neatostema apulum** (L.), comb. nov.

*Myosotis apula* L. Sp. Pl. 1: 131 (1753).

*Lithospermum apulum* (L.) Vahl, Symb. Bot. 2: 33 (1791); Stroh, Beih. Bot. Centralb. 58<sup>b</sup>: 204 (1938).

*Rhytispermum apulum* (L.) Reichenb. Icon. Fl. Germ. 18: 67, t. 1313, f. 8–14 (1858).

*Lithospermum apulum* f. *cleistogamum* Murbeck [Contr. Fl. Moroc. 2:] Lunds Univ. Årsskrif. n. f. Avd. 2, 19(1): 23 (1923).

A well-known plant widely distributed about the Mediterranean and eastward to Mesopotamia. It also occurs on the Canary Islands. Its corollas are distinctive. The stamens, on very abbreviated filaments, are borne just above the basal nectary in the tube and hence extremely low in the corolla. The corolla-throat has no intruding appendages but does have five small densely villous spots, or the latter more or less united to form a narrow villose band. The corolla-lobes on both surfaces are microscopically glanduliferous and velvety-puberulent. The tube is hairy on the inner as well as outer surface. The style is extremely short and at maturity is greatly overtopped by the nutlets. The nectary is very well developed and consists of ten projecting somewhat villulose closely juxtaposed quadrate lobes.

The nutlets are coarsely roughened and angulate. One of their distinctive features is the development of two adjacent paralleling lines of warts down the middle of the dorsum. The body of the nutlet is somewhat bent and the attachment appears to be oblique and suprabasal. Dissection shows, however, that inside the nutlet the tip of the cotyledons is directly above the attachment-surface. Whatever the appearance, the attachment is morphologically basal. As in *Mairetis*, the gynobase of *Neatostema* is flat or slightly higher in the middle and hence very depressed pyramidal. At extreme maturity, as a result of shrinkage of tissue, the gynobase may actually become lowest at the center.

Another rather unusual feature of *Neatostema* is the frequent development of cleistogamic flowers. Such flowers have tiny obconic corollas which eventually fall off unopened. Their calyx and fruit, as well as the cymes in which they are borne, are normal in appearance. Cleistogamy is known among a few American species of *Lithospermum* but has not been reported in the Old World species of the genus nor in related genera.

The expanded pollen grains of this genus are not unlike those of various species of *Lithospermum* and related genera, but the behavior of the dry grains as they expand in lactic acid is very different. In lactic acid the grains first become cylindric and because of their low-convex polar ends are almost oblong in lateral profile. Their most distinctive feature at this stage, however, is a localized strong deep narrow constriction halfway between the poles. In this well-marked deep equatorial groove the pores appear as eight sac-like depressions. These features all disappear as the

grains swell to full size. The expanded grain is ellipsoidal, broadest at the equator, and in lateral profile with the sides slightly angulate.

## B. SUPPLEMENTARY NOTES ON LITHOSPERMUM

DURING the past summer I had the opportunity of visiting Kew, London, and Paris, and examining the representation of *Lithospermum* in the large herbaria there. Through the courtesy of the curators, critical specimens of the genus which I selected were subsequently loaned me for close study at the Arnold Arboretum in conjunction with other critical specimens kindly sent at my request from Vienna. While preparing my recent paper on *Lithospermum*, Journal Arnold Arboretum 33: 299–366 (1952), I had no material available of two Afghan species, *Arnebia inconspicua* Hemsl. & Lace and *A. speciosa* Aitch. & Hemsl., nor was I aware that Dr. Rechinger had just published several closely related species also from Afghanistan. Material from the sources previously mentioned now makes it possible to describe and discuss these plants. Having seen more specimens, it is also possible to modify and extend my previous descriptions of a few other Asiatic species. Unhappily, a change of name for one of the most widely known species in the genus must also be recorded.

### *Lithospermum cyrousianum* (Parsa), comb. nov.

*Arnebia cyrousiana* Parsa, Kew Bull. 1948: 211 (1948).

*Arnebia echioides* (L.) DC. Prodr. 10: 96 (1846).

*Lithospermum Tournefortii* Johnston, Jour. Arnold Arb. 33: 336 (1952).

The type of *Arnebia cyrousiana*, in the Kew Herbarium, has been studied. Its corollas have been dissected and its pollen examined. The specimen has all the characters of the plant well known to gardeners as *Arnebia echioides*, and at most is only a minor phase of the same species. The single plant mounted on the type-sheet has long-styled flowers, but both short- and long-styled corollas are represented in the pocket associated with it. Of all the synonyms of *Arnebia echioides* only Parsa's binomial has a specific epithet that can be used when the species is transferred to the genus *Lithospermum*. The binomial *Lithospermum cyrousianum* must replace *Lithospermum Tournefortii*, the name recently proposed by me when I was unaware of the identity of Parsa's species.

### *Lithospermum fimbriopetalum* (Stocks) Johnston, Jour. Arnold Arb. 33: 326 (1952).

*Arnebia fimbriopetala* Stocks in Hooker, Jour. Bot. & Kew Misl. 3: 180, t. 6 (1851).

*Arnebia Bungei* Boiss. Fl. Orient 4: 215 (1875).

*Lithospermum Bungei* (Boiss.) Johnston, Jour. Arnold Arb. 33: 326 (1952).

Annual herb 5–15 (–40) cm. tall, sparingly branched. Leaves thickish, sparsely hairy or glabrous on the lower surface. Flowers heterostylic. Corolla yellow, 25–30 mm. long; limb 10–20 mm. broad, the lobes broad,

rounded, margins distinctly lobulate or lacerate; throat bearing no glands nor appendages; tube slender, 20–24 mm. long, surpassing the calyx 5–8 mm., above the base inside bearing a membranous more or less hairy collar-like nectary 0.5–1 mm. high. Style slender, forked at apex, lobes 0.5 mm. long. Stigmas 2, compressed, as broad as long, obscurely bilobed. Long-styled flowers with corolla-tube cylindric, abruptly enlarging in diameter 6–8 mm. below the summit; anthers 2–2.3 mm. long, borne low in the upper third of the corolla-tube; pollen moderately constricted at the middle,  $42\text{--}50 \times 28\text{--}33 \mu$ ; style almost as long as the corolla-tube. Short-styled flowers with the tube gradually ampliate; anthers 2–2.3 mm. long, borne at summit of tube with their upper third exerted into the throat; pollen with sides straight and parallel or slightly concave,  $46\text{--}56 \times 33\text{--}41 \mu$ ; style two thirds as long as the corolla-tube. Calyx 15–17 mm. long at anthesis (with linear lobes), becoming very strongly accrescent (with lanceolate or ligulate lobes) in fruit, at maturity 25–30 mm. long with the major lobes 3–5 mm. broad near the base, glabrescent with the midrib and a few veins becoming evident, at times with papillate excrescences on the midrib of the lobes near the base. Nutlets olivaceous or rubiginous, tuberculate, 3–3.5 mm. long, 3 mm. broad at the base, beaked above the middle, lower half of dorsum swollen on either side of a broad medial depression, upper half with a low rounded medial keel, venter angulate, attachment-surface broadly triangular, basal. Gynobase very depressed.

BALUCHISTAN: Upper Baluchistan, *Stocks* 977 (Kew, TYPE of *A. fimbriopetala*); Gival, 5–6000 ft., 6/5, *A. V. Monro* ex Duthie (Kew).

PERSIA: 20 mi. from Isphan on Shiraz road, 6000 ft., open hills, Apr. 1944, *A. C. Trott* 906 (Kew); pr. Sser-tschah, March 12, 1859, *A. Bunge* (G, ISOTYPE of *A. Bungei*).

A careful study and comparison of the above cited collections has shown conclusively that *Arnebia fimbriopetala* and *A. Bungei* are conspecific. The species is most closely related to *Lithospermum detonsum* of northern Persia and Transcaucasia, agreeing with that more northern and western plant in habit of growth, in large, much accrescent calyces, and in size, form, and markings of nutlets. It differs sharply from *L. detonsum* in several respects. Unlike that species its flowers are decidedly heterostylic. Furthermore, its corollas are not merely larger but also have a more elongate tube, conspicuously longer than the calyx, and lobes that are not entire but evidently lobulate or lacerate-fimbriate on the margin.

**Lithospermum Szechenyi** (Kanitz) Johnston, Jour. Arnold Arb. 33: 330 (1952).

My previous description of this species was based on a collection with short-styled flowers from Hsueh Hwa, Kansu (*R. C. Ching* 731), supplemented by the original description (of a long-styled plant) given by Kanitz. Additional information concerning this species of western China

is now available through the study of three collections made by Father Licent. These were obtained at Ta-la-chi, Kansu (ca. 150 km. n. e. of Lanchow), no. 4017, and at Sain-Nor, at the base of the Scharanarin-ula [Khara-narin ula] northwest of the Ordos in southern Inner Mongolia, almost 600 km. north-northeast of Lanchow, nos. 13612 and 13621. The first collection, at the British Museum, contains both long- and short-styled flowers. Of the two other collections, both at Paris, *Licent* 13612 is a short-styled plant with fruit; *Licent* 13621 is the long-styled plant. These collections of Licent are less robust plants than those previously described, having noticeably more slender stems and narrower leaves. Their stems, 2.5 mm. thick at the base, are 2–4 dm. long and may become decumbent. The largest middle cauline leaves are 2–2.5 cm. long and only 5 mm. broad. The bracts in the cymes are elongate, foliaceous, and broader than the calyx-lobes. The corollas are 16–19 mm. long and retain evidences of having been yellow and provided with evanescent dark spots. The corolla-tube is 11–14 mm. long. There are no glands on the inner surface of the throat as reported previously. The style is not forked at the apex. Its two stigmas are terminal and juxtaposed. In the short-styled flowers the corolla-tube is gradually ampliate, the anthers (3 mm. long) are borne at the summit of the tube and partially exerted into the throat, the pollen ( $39-43 \times 25-26\mu$ ) is barrel-shaped, having rounded ends and sides that are parallel or only very slightly concave; the style reaches up to the middle of the corolla-tube. In long-styled flowers the cylindric corolla-tube has a slight but distinct increase in diameter just above the middle, the anthers (1.3–2 mm. long) are borne at the middle of the corolla-tube, the pollen ( $30-33 \times 16-20\mu$ ) is evidently constricted at the middle, and the style reaches up into the corolla-throat. The mature nutlets, 2.5 mm. long and 1.5 mm. broad, are weakly constricted just above the base and are abundantly tuberculate. Some of the wart-like roughenings are rounded but others bear a minute point or short stout hair and can almost be described as muricate. The attachment surface of the nutlet is broad, flat, and obliquely basal. The venter of the nutlets is angulate. The dorsum is rounded and obscurely keeled only towards the apex.

**Lithospermum Hancockianum** Oliver in Hooker, *Icones* 25: t. 2457 (1895); Johnston, *Jour. Arnold Arb.* 33: 354 (1952).

Among some duplicates recently received from Paris are six hitherto unstudied collections of this remarkable species from eastern Yunnan. They provide more numerous and better corollas for dissection than were previously available to me. I am, accordingly, able to correct and emend my previous description of the plant. The species appears to have weakly dimorphic flowers. The ten collections at hand sort into two types. One has the style evidently exerted from the corolla-tube, usually 3–5 mm., and the other has the style equaling the tube in length or 1–2 mm. shorter. In both types the anthers (1.5–1.7 mm. long) are borne at the summit of the corolla-tube. Those in the long-styled flowers tend to have their tips reaching only to the summit of the corolla-tube, while those in short-styled

flowers tend to have the upper third of their length projecting above it. All the flowers on a given plant appear to belong to one or the other of these two types. There is no accompanying difference in pollen. Minute stipitate glands are abundant on the corolla-tube behind the anthers, in a band extending 1 mm. below to 1 mm. above the filament-attachments. They occur sparingly in the tube as far down as 5 mm. below its summit. The filaments are broadly affixed, attenuate, and laterally compressed and accordingly unguiculate. The style is perceptibly forked at the extreme apex, and its two oblong stigmas may become divergent. The glabrous nectary in the tube is not continuous but made up of ten projecting, closely juxtaposed quadrate lobes. The nutlets are white, smooth, sparingly pitted, stout pointed ovoid, 2.5–3 mm. long and 2 mm. thick. They have a lineate constriction just above the broad obliquely basal attachment-surface. The dorsum is convex and is keeled only near the apex. The venter is angulate and evidently keeled. The gynobase is depressed pyramidal.

**Lithospermum Lindbergianum** (Rech. f.), comb. nov.

*Macrotomia Lindbergiana* Rech. f. Ann. Naturhist. Mus. Wien 58: 58 (1951).

Plant perennial, with a stout taproot crowned by a small caudex; branches of caudex short, stout, clothed with persistent leaf-bases. Indumentum cinereous, composed of numerous very slender, usually spreading bristles 2–5 mm. long and an abundance of very minute, frequently retrorse hairs 0.2–0.5 mm. long. Flowering stems 4–6 cm. long, erect, slender, simple, 1–2 mm. thick at the base, arising from the center of a cluster of functional leaves, terminated by the inflorescence. Leaves with an evident midrib, veinless; basal ones linear-oblongate, becoming 4 cm. long, 2–3 mm. broad below the acute apex; cauline leaves few, attenuate, gradually reduced up the stem, uppermost 2–3 cm. long, 1.5–2 mm. broad near the middle. Inflorescence a dense capitate terminal cluster ca. 4 cm. in diameter, comose from an abundance of slender protruding sepals; bracts shorter than the calyx. Calyx at anthesis 23–24 mm. long, hispid; lobes linear-attenuate and more or less flexuous, 21–22 mm. long, 0.8 mm. broad at the base, surpassing the corolla 2–4 mm. Calyx in fruiting state 30 mm. long, inside below the middle densely appressed white villose. Flower heterostyled with only the short-styled form known. Corolla 19–21 mm. long, slender and elongate, abundantly pubescent outside, inside glabrous except on the nectary; tube 16–17 mm. long, ca. 1.5 mm. thick for most of its length, upper 3 mm. of length swollen (and staminiferous) and 2–2.5 mm. thick, slightly constricted at the very summit, inside just above the base bearing a distinct membranous collar-like nectary 0.3–0.4 mm. high which is sparsely villose on the inner face; throat funnelform, short, 2–3 mm. long, sparingly glanduliferous inside; limb ca. 4 mm. broad, composed of ascending triangular-ovate lobes ca. 1.7 mm. wide and 2 mm. long. Anthers 2.5 mm. long, borne just below the summit of the corolla-tube. Pollen  $33\text{--}35 \times 25\text{--}26 \mu$ , in lateral profile with the sides parallel or practically so. Style 11–12 mm. long, reaching up to slightly above the middle of the corolla-

tube, forked at the summit, the lobes 0.8–1 mm. long; stigmas 2, unequal, spathulate. Nutlets (only sub-mature ones seen) erect, lanceolate, 3.5 mm. long, 2.5 mm. broad below the middle, surface dull, densely and very minutely papillate, venter with prominent keel, dorsum with an obscure partial keel and probably irregularly tuberculate when completely mature, attachment broad and obliquely basal. Gynobase depressed pyramidal.

AFGHANISTAN: Bamian, Ajdaha, May 24, 1947, *K. Lindberg s.n.* (TYPE, Vienna).

This very distinct species is known only from a single collection obtained in the mountains about 100 km. northwest of Kabul, Afghanistan. Judging from the totality of its characters the plant is evidently a member of the group of species containing *L. Benthami*, *L. superbum*, *L. nobile* and *L. euchromon*. It comes from the same floristic area and has very similar elongate corollas with purpurent limb. It differs from all these relatives in the small size of the plant and in having a well-developed collar-like nectary low in the corolla-tube. The nectary is especially noteworthy. In the related species mentioned the corolla-tube bears no nectary nor any rudiment of one such as tufts of hairs nor discolored or slightly swollen tissue. Those authors who have assigned such species to the segregate genus *Macrotomia* have usually laid great stress on the absence of a nectary. Though the present species in all other technical characters, as well as in general appearance, gives every evidence of close affinity with the species mentioned, it would be divorced from them in any classification in which the presence or absence of a nectary is made arbitrarily into a crucial character. We have here, in fact, further evidence that *Macrotomia* is neither a natural nor useful segregate; cf. Jour. Arnold Arb. 33: 313 (1952).

The present species agrees with its obvious relatives not only in the form of the corolla but also in the type of coloration. The corollas found on herbarium specimens of these species show no evidence of decided orange or yellow coloration so common in other groups of the genus. In drying they tend to become brownish, pinkish, or whitish, but in most inflorescences some are to be found having purple or purplish lobes and throat. The indications are that the corollas of this group of species have striking color-changes associated with the state of maturity. A collector of *L. nobile* reports the corollas as at first dark brown but later yellow. Aitchison, Jour. Linn. Soc. 18: 19 (1880), states that *L. euchromon* is "remarkable for its flowers varying from greenish yellow to deep purple-black." Although collectors of *L. inconspicuum* report the corollas as creamy or pale yellow, some of the corollas on their dried specimens have decidedly purple or purplish throat and limb.

The five species most closely related to *L. Lindbergianum* are distinguished from it in the following key:

Inflorescence globose or broader than long; leaves with midrib only.

Corolla with a well-developed collar-like nectary in the tube; stems less than

1 dm. tall, arising from the center of a leaf-cluster; leaves narrow, 2–3 mm. broad; calyx linear-attenuate as much as 0.8 mm. wide at base

..... *Lithospermum Lindbergianum*.

Corolla without a nectary in the tube.

Plant gray or silvery, the herbage not glanduliferous; calyx-lobes subulate-linear, 1 mm. wide at base; corolla with stipitate glands in the throat; stems less than 1.5 dm. tall, arising from the center of a basal leaf-cluster; leaves less than 5 mm. broad

..... *Lithospermum inconspicuum*.

Plant green or somewhat tawny, the herbage usually glanduliferous; calyx-lobes lanceolate, 1–3 mm. broad; corolla without glands in throat; stems to 4 dm. tall, arising lateral to the basal cluster of leaves; leaves usually 5–10 mm. broad.

..... *Lithospermum euchromon*.

Inflorescence elongate, a cylindrical thyse evidently much longer than broad; lower leaves with 3–5 evident longitudinal ribs.

Thyse continuous, with numerous exerted bracts; calyx-lobes very slender and flexuous.

..... *Lithospermum Benthami*.

Thyse interrupted, only the lowermost bracts protrudent; calyx-lobes stiff.

Basal leaves hispid; corolla hairy outside, not glanduliferous

..... *Lithospermum speciosum*.

Basal leaves strigose; corolla glanduliferous but usually otherwise glabrous

..... *Lithospermum nobile*.

### ***Lithospermum inconspicuum* (Hemsl. & Lace), comb. nov.**

*Arnebia inconspicua* Hemsl. & Lace, Jour. Linn. Soc. 28: 326 (1891).

*Arnebia argyrea* Rech. f. Ann. Naturhist. Mus. Wien 58: 59 (1951).

Plant with herbage and stems pale and somewhat silvery from a dense mostly appressed indument composed of abundant pallid hairs of two sizes, coarse hairs 1–2 mm. long and minute very slender hairs 0.2–0.5 mm. long; perennial with a rather dense caudex formed of crowded branches ensheathed by old leaf-bases. Leaves firm, oblanceolate, 1–5 cm. long, 2–5 mm. broad, with evident midrib but no veins. Stems arising from the center of a leaf-rosette, usually 3–15 cm. long, 1–3 mm. thick at the base, simple, terminated by the capitate inflorescence, rarely much reduced in length and bearing the inflorescence in the center of the leaf-rosette. Middle and upper stem-leaves not numerous, not conspicuously smaller than the basal leaves. Cymes congested into a dense terminal capitate cluster 1.5–3.5 cm. in diameter at anthesis. Inflorescence lacking conspicuous bracts but frequently with some of the uppermost stem-leaves crowded at its base, rarely developing a small secondary cluster of cymes in leaf-axils below the major terminal cluster. Calyx 12–17 mm. long; lobes subulate-linear, 10–16 mm. long, ca. 1 mm. broad at the base, reaching up to the throat of the corolla. Flowers heterostylic. Corolla narrow and elongate, 12–19 mm. long, surpassing the calyx 2–3 mm., whitish or yellow, frequently somewhat purpureous in drying, outside evidently appressed hairy, inside glabrous or with scattered hairs on the corolla-lobes; limb ascending, 2.5–4.5 mm. broad; tube-nectary not developed; throat short, ca. 2 mm. long, funnelform; lobes ascending, acute, ovate-triangular, 1–2 mm. long; throat somewhat glanduliferous, at least

in the short-styled flowers; tube 9–14 mm. long, in long-styled flowers cylindric 12–14.5 mm. long and 2 mm. thick, in short-styled flowers 1–1.5 mm. thick below the middle and above very gradually broadening into the throat. Anthers 2 mm. long, borne on very short filaments either above the middle of the corolla-tube or in the corolla-throat. Pollen of short-styled flowers  $40\text{--}43 \times 24\text{--}28 \mu$ , in lateral profile with sides straight and parallel or at most only slightly concave. Style evidently forked (branches slightly unequal), reaching to slightly above middle of corolla-tube or into the corolla-throat, short styles ca. 7 mm. long with lobes 1 mm. long, long styles ca. 15 mm. long with lobes 2–3 mm. long. Stigmas 2, distinct, compressed, nearly as broad as long. Fruiting state of plant and its fruit unknown.

BALUCHISTAN: Zahru, *Stocks* 866 in pt. (Kew); without locality, 1891–94. C. F. Elliott (Kew).

AFGHANISTAN: Kabul, Gul Tara, fl. creamy white to yellow, *Neubauer* 364 (Vienna); Cabul, H. Collett 18 (Kew); Nozi, fl. pale yellow, 10000 ft., W. Koelz 12015 (Vienna, TYPE of *A. argyrea*); Obeh, 1600 m., M. Köie 4403 (Vienna); Tscharikar, Top Tara, *Neubauer* 610 (Vienna); Jagdalek, fl. pale yellow, 7000 ft., *Koelz* 11485 (Vienna).

A very distinct and readily recognizable species notable for its rather silvery indument and dense capitate inflorescence. Evidently a member of the same group of species as *L. Benthami* and *L. euchromon*, although not obviously related to any particular member of it. In technical characters it departs from all its allies in having stiputate glands on the inner surfaces of the corolla-throat.

*Lithospermum speciosum* (Aitch. & Hemsl.), comb. nov.

*Arnebia speciosa* Aitch. & Hemsl. Proc. Linn. Soc. 18: 81 (1880) and 19: 179. t. 24 (1882).

Plant perennial, coarse, very bristly. Stems simple, erect, becoming 4 dm. (6 dm. fide Aitch. & Hemsl.) tall and 8 mm. thick at the base, arising from the center of the basal leaf-cluster, hispid, its bristles 2–4 mm. long and towards the base of the stem retrorsely deflexed but elsewhere widely spreading. Leaves firm, those below the middle of the stem with three strong longitudinal ribs, hispid, the hairs 1–2 (–3) mm. long, slender, stiff, spreading to ascending and sometimes retrorse, those on the upper leaf-surface arising from minute discoid bases. Basal leaves to 10 cm. (15–25 cm. fide Aitch. & Hemsl.) long, narrowed above the broad sheathing dye-stained base, broadest (7–10 mm.) above the middle and then gradually narrowed to the acute apex. Cauline leaves gradually reduced up the stem, the middle ones lanceolate, 5–7 cm. long, 5–8 mm. broad near the base. Inflorescence an elongate interrupted cylindrical thyse, 15–25 cm. long, 5–7 cm. thick, composed of a small terminal cyme and 10–15 slightly larger short-pedunculate cymes borne in the leaf-axils along the upper half of the stem. Cymes densely flowered, at first glomerate and 3–5 cm. broad, but

in age tending to elongate and become evidently scorpioid (and eventually perhaps 4–7 cm. long); bracts shorter than the adjacent calyces; subtending leaves surpassing only the lower cymes. Calyx hispid, 17–18 mm. long at anthesis, 21 mm. long in fruit, if bearing stipitate glands these very few and inconspicuous; lobes ca. 15 mm. long, 1.5–2 mm. broad near the base, reaching up to the tip of the corolla-lobes or surpassing them 1–2 mm. Flowers heterostylic, but only the short-styled form seen. Corolla 16–17 mm. long (20–24 mm. fide Aitch. & Hemsl.), elongate, outside evidently hairy, especially on the lobes, bearing few if any stipitate glands, inside glabrous and devoid of basal nectary; tube 13 mm. long, 1.2 mm. thick at the middle, above gradually ampliate and becoming 3 mm. thick at the summit; throat short and broad; limb about 7 mm. broad, lobes ascending, 2.5 mm. broad and 2 mm. long, apex rounded. Anthers 2 mm. long, borne at the summit of the tube and partly exerted into the throat. Pollen (poor condition)  $39\text{--}42 \times 23\text{--}28 \mu$ , sides evidently concave, pores 6 at each end. Style 5 mm. long, reaching up to the middle of the corolla-tube, obscurely forked at the apex, lobes ca. 0.3 mm. long. Stigmas 2, compressed, broader than long. Nutlets gray or brown, erect, 4–5 mm. long, attached obliquely by the broad base to a low-pyramidal gynobase, with a narrow very prominent ventral keel, apex truncate and sometimes toothed, back 2–3 mm. broad below the middle, then narrowed to the laterally compressed apex, usually with evident longitudinal ridges paralleling the dorsal keel, surface minutely tuberculate and irregularly verrucose.

PAKISTAN: hill behind Kaiwas, Kurrum Valley, 9–12000 ft., open grassy spots, July 3, 1879, *Aitchison* 720 (TYPE, Kew).

I know this species only from the type specimen which is described above. The plant is related to *L. Benthami* of the Himalayas of north-western India and Kashmir and to *L. nobile* of the high transverse ranges of eastern Afghanistan. It seems to be more like *L. Benthami*, with which it agrees in nutlets and pollen. It differs, however, in being clothed in stiffer, more spreading hairs and in having broader, stiffer, non-flexuous calyx-lobes and a not continuous but distinctly interrupted thyrses with not numerous but few if any salient bracts. From *L. nobile* it differs in the form of nutlets, smaller pollen, lack of evident stipitate glands, hairy outer corolla-surfaces, hispid rather than neatly strigose basal leaves, and perhaps more rounded tips of the corolla-lobes. The color of the corolla is not reported by the collector. As with specimens of *L. nobile*, however, some of the non-faded younger corollas on the type-specimen have distinctly purple lobes and throat.

***Lithospermum nobile* (Rech. f.), comb. nov.**

*Arnebia nobilis* Rech. f. Ann. Naturhist. Mus. Wien 58: 58 (1951).

Plant coarse, perennial. Stems erect, 2–5 dm. tall, as much as 8 mm. thick at the base, arising from the center of a basal cluster of leaves, below the middle usually antrorsely strigose, above the middle usually with some spreading hairs and commonly glanduliferous. Basal leaves firm, 8–23 cm.

long, with 3–5 longitudinal ribs, narrowed just above the broad sheathing dye-stained base, broadest (3–22 mm.) above the middle, apex slenderly acute, indument of short strongly appressed pallid hairs, hence neatly strigose. Cauline leaves gradually smaller up the stem, middle ones broadest at the base, 2–8 mm. wide, attenuate, usually clothed with appressed hairs and frequently ciliate on the margins. Inflorescence an elongate interrupted thyse, cylindric, 5–12 cm. broad, at least several times as long as broad, composed of a small terminal cyme and numerous short-pedunculate lateral cymes arising from the leaf-axils along the upper half of the main stem and occasionally even down to near its base. Cymes densely flowered, at first glomerate and 2–3 cm. in diameter, eventually elongating, becoming scorpioid and 5–15 cm. long in fruit, hispid and glanduliferous; bracts shorter than the adjacent calyces; upper stem-leaves soon surpassed by the subtended cymes, only the lower ones protruding from the thyse. Calyx hispid, frequently somewhat tawny, bearing scattered minute stipitate glands, 15–18 (–20) mm. long at anthesis, becoming as much as 25 mm. long in fruit; lobes 1–2 mm. broad, acute, in long-styled flowers 1–6 mm. shorter than the corolla, in short-styled flowers equaling the corolla or surpassing it 1–2 mm. Flowers heterostylic. Corolla elongate, 16–20 (–27) mm. long, outer surface usually bearing scattered stipitate glands but otherwise usually glabrous, inside glabrous, without basal nectary in the tube; corolla-tube 12–15 (–20) mm. long, 1–1.5 (–2) mm. thick below the middle, in short-styled flowers gradually ampliate above the middle and becoming 2.5–3 mm. thick at the summit, in long-styled flowers with upper 5 mm. cylindric and 2.5–3 mm. thick; throat short, abruptly enlarged and rounded, inside without gland or appendages; limb 5–7 (–10) mm. broad, lobes usually more or less triangular and commonly 2.5 mm. broad and 2–2.5 mm. long, ascending, the margins and tip of the lobes somewhat recurved. Anthers 2.3–2.5 (–3) mm. long; in short-styled flowers borne high in the tube (with their bases ca. 1 mm. below its summit) and protruding up into the corolla-throat; in long-styled flowers borne low in the upper cylindric section of the corolla-tube, their bases 5 mm. below the summit of the tube. Pollen with 6 pores at each end of the grain, in short-styled flowers subcylindric with rounded ends, in lateral profile with sides parallel or only very slightly concave,  $49 \times 33\text{--}35 \mu$ ; in long-styled flowers evidently constricted at the middle,  $33\text{--}38 \times 18\text{--}23 \mu$ . Style reaching up to slightly above the middle of the corolla-tube or to the summit of the tube or even into the base of the corolla-throat, forked at the apex, lobes unequal, 0.5–1 (–1.5) mm. long; stigmas 2, compressed, broader than long. Nutlets gray, erect, usually only one developing, ca. 7 mm. long, broadest (2.5–3 mm.) at or just above the base, gradually narrowed upwards into a somewhat rostrate incurving apex, hence narrowly subconic in form, ventral and dorsal keel obscure except on the upper 2–3 mm. (i. e., on the beaked apex), surface very minutely tuberculate, longitudinally striate and rugose, the rugae irregular and sparsely verrucose; attachment-surface broad, obliquely basal. Gynobase low pyramidal.

AFGHANISTAN: Sanjadabad, May 1880, *H. Collett* 22 (Kew); Sanjadabad, 7000 ft., April 1880, *H. Collett* 77 (Kew); Dscheratu, May 7, 1949, *H. F. Neubauer* 836 (Vienna, TYPE of *A. nobilis*); Paghman, rocky slope, 7000 ft., fl. at first dark brown, later yellow, leaves silvery, July 14, 1935, *W. R. Hay* 350 (Kew); Sar-i-chasma, 2700 m., June 3, 1948, *L. Edelberg* 1832 (Vienna); Hauz-i-Mahik, 2500 m., July 12, 1948, *M. Köie* 3166 (Vienna); Farakulum, 3000 m., July 19, 1948, *M. Köie* 3167 (Vienna).

A species of the high mountains (Hindu Kush) of eastern Afghanistan and most closely related to the more southerly ranging *L. speciosum* of the Pakistan-Afghanistan border. Distinctive of the species are its tidy and decidedly strigose basal leaves, the numerous stipitate glands on the inflorescence, calyx, and outer corolla-surface, the large pollen, and the narrowly conic longitudinally striate nutlets with incurved beak. Among the collections cited only one (*Hay* 350) has hairs on the outer surface of the corolla. Only one fruiting collection has been seen (*Edelberg* 1832). The elongate erect nutlets, broadest at or near the base and gradually narrowed upwardly into a slightly incurved beaked apex, have a form unique in *Lithospermum*. The roughening of their surface, numerous narrow longitudinal usually verrucose ridges which are separated by lineate grooves, is also unique. Another unusual feature is the suppression of the ventral keel except on the beak of the nutlet.

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